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SUITABILITY OF USING COMMON SELECTION TEST STANDARDS FOR NEGRO AND WHITE AIRMEN

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Air Force Human Resources Laboratory
Brooks Air Force Base, Texas

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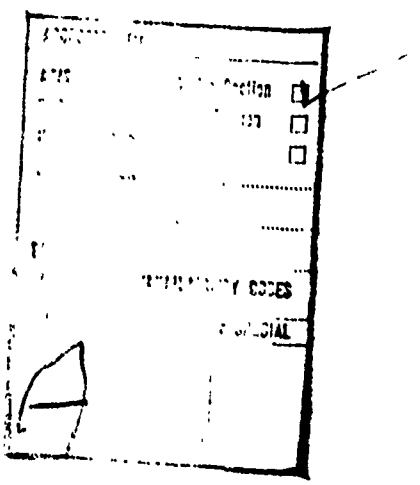

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Airman Qualifying Examination						
Selection Test						
Security Knowledge Test						
Classification						
Navy Airmen						
Computation						
Job Prediction						

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FOREWORD

This study incorporates analyses of data derived from airman historical data files maintained by the Personnel Research Division (AFHRL). The work was supported in part by the Personnel Research Division under Project 7719, Air Force Personnel System Development on Selection, Assignment, Evaluation, Quality Control, Retention, Promotion, and Utilization; Task 771909, Development and Validation of Specialized Test Measures for Specific Subgroups of Air Force Personnel.

This report has been reviewed and is approved.

George K. Patterson, Colonel USAF
Commander

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SUITABILITY OF USING COMMON SELECTION TEST STANDARDS FOR NEGRO AND WHITE AIRMEN

I. INTRODUCTION

Merit is the basis of personnel selection in the Air Force, as it is generally in our society. Aptitude and achievement tests have played an important role in selection because they can provide for objective and effective measurement of merit. Although use of such tests undoubtedly increases the effectiveness of selection decisions, the fact that they are imperfect assessment instruments leads to a justifiable concern regarding individuals whose abilities or potential performances may not be adequately reflected by the test results.

Recently there has been increasing interest (Ginzberg, 1971) concerning the appropriateness of applying the same selection standards to all individuals belonging to a population consisting of heterogeneous subgroups. Whether selection standards should be applied uniformly to all subgroups or whether different standards should be used for different subgroups are questions involving both economic and moral considerations. If the relationship between performance on selection tests and performance on criterion measures is substantially different for subgroups, then the establishment of unique selection standards for each subgroup could lead to a more effective (*i.e.*, economic) utilization of manpower resources as well as a more equitable treatment of those subgroups whose criterion performance would otherwise be underpredicted.

As has been clearly stated in various studies (Kirkpatrick, Ewen, Barrett, & Katzell, 1968; Guinn, Tupes, & Alley, 1970a), the need to establish different selection standards for subgroups is not indicated merely by different levels of subgroup performance with respect to either selection or criterion measures but, rather, depends on a difference between subgroups in the relationship between selection and criterion performance. Whether a particular subgroup is over- or underpredicted is determined by that subgroup's relationship to a prediction made for all individuals without regard to subgroups. For example, if the prediction for a subgroup falls below the common prediction, that subgroup is said to be overpredicted by the selection test. An inequity or inefficiency in the selection process exists only when the criterion performance of a subgroup is over- or underpredicted by the selection test scores. Bias against a subgroup exists when that subgroup's criterion scores are underpredicted.

Previous investigations of subgroup performance differences have been primarily concerned with comparisons of racial subgroups. Studies in industrial and military settings have investigated the question of racial variations in selection procedures. Lopez (1966) found that predictors valid for Negroes were not always valid for whites. He concluded that the use of separate selection procedures for each race was the fairest approach. Kirkpatrick *et al.* (1968) found that in some cases the criterion performances of Negroes were underpredicted from their selection test scores, in comparison to a white group. Campbell, Pike, and Flaugher (1969) found overprediction of Negro scores when performance on a test of job knowledge was predicted from an aptitude battery. In a military setting, Gordon (1953) found underprediction of Negro performance in several cases and one case of overprediction. She concluded that racial differences were not sufficiently large to require separate selection standards. Guinn, Tupes, and Alley (1970b) found that the technical school grades of Negroes were overpredicted in several cases. They drew no final conclusions concerning differential selection standards but suggested that further research be conducted to provide cross-validation.

Of possible relationships between the selection and criterion scores, six generic relationships, relevant to this study, are graphically presented in Figure 1. Where subgroup regression lines differ, the common regression line would be intermediate between the subgroup regression lines. The first illustration represents the optimum relationship where the selection test is valid for both subgroups in predicting the criterion, and the criterion scores of both subgroups are neither under- nor overpredicted. The second and third illustrations represent cases where the selection test is valid for only one subgroup, and there is bias against one subgroup. By contrast, the fourth represents a condition where the selection test is valid for only one subgroup, but there is no overall subgroup bias. The fifth example illustrates the condition

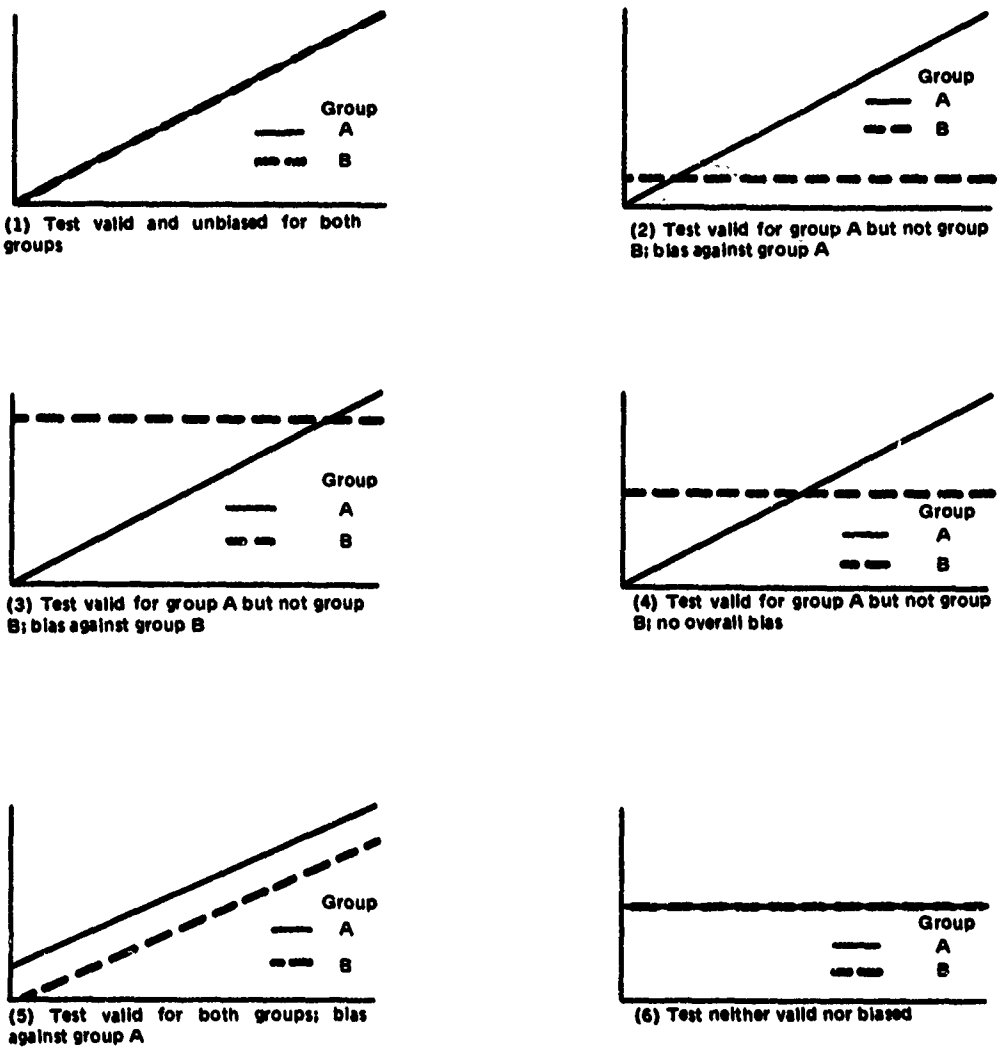

Fig. 1. **Graphic representation of certain generic relationships between selection and criterion scores.** (The criterion is represented on the vertical axis and the predictor on the horizontal axis.)

where the selection test is valid for both subgroups, but consistently biased against one subgroup. In the sixth example, the selection test is neither valid nor biased for either subgroup.

The present study examined the relationship between selection test scores and criterion test scores for both Negro and white airmen. The principal question of this study was: Is it equitable to apply the same selection test standards to both Negro and white airmen? In other words, are Negro or white criterion scores either under- or overpredicted by Air Force selection tests? A subordinate question was: Are the selection tests valid to different degrees for the racial subgroups?

II. METHOD

Subjects

The subjects were 31,208 of the airmen who were tested under the Weighted Airman Promotion System between October 1969 and March 1970. Of the total sample 5,444 were Negro airmen. The total sample consisted of 16 groups of airmen competing within groups for promotion. Each group contained at least 50 Negro airmen. The numbers of Negro and white airmen in each group are shown in the Results section. It was not assumed that the subjects of this study are representative of their race.

Predictor Variable

Aptitude indexes (AIs), derived from the Airman Qualifying Examination (AQE), were used as the predictor variable. The AQE, administered to all non-prior-service volunteers before enlistment, consists of ten subtests which are combined to yield four aptitude indexes: General, Administrative, Mechanical, and Electronics. The raw scores are converted into a 20-interval percentile scale. Career field entry is based on attainment of a minimum score on the AI related to that career field. The range of AQE scores used in this study was truncated; those examinees with nonqualifying AI scores were not allowed to enter that career field.

Performance Criterion

The appropriate Specialty Knowledge Test (SKT), a factor in the Weighted Airman Promotion System, was used as the criterion. These tests are designed to measure knowledge of the specialty as it is defined in Air Force Manual 39-1, *Airman Classification Manual*, and the Specialty Training Standard. Although the SKT does not measure how well an airman actually performs in his job, it does measure his ability to solve on-the-job problems. The available SKT performance data were in the form of percentile scores. The estimated elapsed time from AQE administration to SKT administration ranged from 2.4 years for 4-level SKTs (indicated by a 4 in the fourth digit of the test number) to 17.4 years for 7-level SKTs.

The possibility of a biased criterion must be considered even though the SKT development procedures are intended to minimize the probability of racial bias. The tests are written by teams of test development psychologists and senior noncommissioned officers who serve as subject-matter specialists. Racial and other subgroups are well represented by these team members. Each test item must have content validity, it must be referenced to a specialty-related document, and it must meet the unanimous approval of all team members. The test development psychologists attempt to insure that each test item is clearly and succinctly stated, is easily understood, presents no undue reading difficulty, and generally meets high psychometric standards.

Statistical Method

Predictor, criterion, and racial identification data were retrieved for each subject from the airman historical data files maintained by the Personnel Research Division, AFHRL. Covariance regression techniques as outlined by Bottenberg and Ward (1963) were employed. The regression models and F-tests are shown in Table 1.

Analysis A determined the statistical significance of mean racial differences (*i.e.*, indicating that example 2, 3, or 5 in Figure 1 is representative of the relationship between predictor and criterion). The absence of mean racial differences is consistent with example 1, 4 or 6 in Figure 1. Analysis B indicated whether the AQE predicted criterion scores equally well for the two racial groups (*i.e.*, significant differences indicate differential prediction and that either example 2 or 3 in Figure 1 is representative of the relationships). Determination of the representative figure was made by examining the regression lines. Analysis C indicated whether similar levels of performance on the predictor variable were associated with different levels of performance on the criterion. Differences revealed by this analysis

Table 1. **Covariance Regression Design**

Regression Models

Model 1: SKT = B + W + (B x AQE) + (W x AQE)
Model 2: SKT = B + W + AQE
Model 3: SKT = AQE

F-Tests

$$F = \frac{[(R_F)^2 - (R_R)^2]/(df)_1}{[1 - (R_1)^2]/(df)_2}$$

	Full model		Restricted model
Analysis A	model 1	vs.	model 3
Analysis B	model 1	vs.	model 2
Analysis C	model 2	vs.	model 3

Definitions

SKT	= SKT percentile score
B	= 1 if black, 0 if not black
W	= 1 if white, 0 if not white
AQE	= AQE selector AI percentile score
$(R_F)^2$	= Squared multiple correlation obtained from the Full model
$(R_R)^2$	= Squared multiple correlation obtained from the Restricted model
$(R_1)^2$	= Squared multiple correlation of model 1
$(df)_1$	= Difference between the number of independent vectors in the Full and Restricted models
$(df)_2$	= Number of elements in the vectors minus the number of independent vectors in model 1

indicate that parallel differences in regression lines exist; example 5 in Figure 1 illustrates this condition.

Hypothesis testing had two phases. First, F-tests were computed to determine for which groups mean racial differences were significant (Analysis A). Those groups for which significant differences were found (probability of .10 or less) were further tested to determine the more specific characteristics of the predictor-criterion relationship (Analyses B and C).

III. RESULTS

Descriptive data for all groups are presented in Table 2. Table 3 summarizes the regression analyses. Of the 16 total groups, statistically significant mean racial differences (Analysis A) were found for nine groups. Three of the significant differences were in groups where the Mechanical AI was used as the predictor, four for the General AI, and two for the Administrative AI. No differences were found for groups using the Electronics AI. There was no apparent relationship between statistically significant differences and either grade level or career ladder.

For the seven groups for which statistically significant differences were not found, six groups were best represented by the predictor-criterion relationship shown in example 1 of Figure 1. Example 4 best demonstrates the relationship of the other group where the Negro airmen are represented by the horizontal line.

Analyses B and C further explored the nature of the differences for the other nine groups for which Analysis A resulted in statistically significant differences. For all of these nine groups, the criterion performance of Negro airmen was overpredicted; conversely, SKT performance of white airmen was underpredicted. Differential prediction was found for four groups. Example 2 in Figure 1 best represented two of these groups (solid line for whites), and the remaining two groups were best represented by example 5 (solid line for whites), although the lines diverged somewhat in the upper ranges. Parallel differences were found for the remaining five groups, and the relationships were best represented by example 5 (solid line for whites). The regression equations for each of the promotion groups are given in Appendix II.

IV. DISCUSSION

The results of this study, *i.e.*, the overprediction of Negro criterion scores, cross-validates the findings reported by Guinn *et al.* (1970b) and are parallel to the results of Campbell *et al.* (1969). However, the results are not supported by the findings of Kirkpatrick *et al.* (1968) who, in some cases, found underprediction of Negroes' scores in selected experimental groups.

The "fairness" of a selection test to subgroups should first be viewed in the perspective of selection decisions which would be made without benefit of the test. As opposed to an unsystematic selection process, selection tests which are generally valid for the population as a whole provide an increment of "fairness" in that those individuals who are selected are most likely to benefit themselves and their employers from the opportunity resulting from selection. An unsystematic selection process is unfair to the most deserving individuals, whose merit is not measured and, therefore, may not enter into the selection process.

Although the use of a valid test is an important gain to the selection process, the question can be raised whether the use of the test can be refined so

Table 2. **Means and Standard Deviations for Variables**

AQE AI	Entry Score	Grade Tested	SKT[a]	Race	N	SKT		AQE AI	
						Mean	SD	Mean	SD
Admin	50	E4	64550	Negro	493	37.53	28.29	55.24	16.88
				White	2,378	49.14	28.42	72.32	14.53
Admin	50	E5	64560	Negro	1,150	44.73	28.73	50.13	17.87
				White	2,334	48.98	28.87	57.88	19.10
Admin	50	E6	64570	Negro	483	43.57	29.33	51.36	20.54
				White	1,766	48.63	28.50	58.52	21.11
Admin	60	E5	73260	Negro	196	45.85	28.44	65.94	14.82
				White	1,211	47.85	28.14	72.89	14.71
Elec	40	E4	42153	Negro	115	43.75	26.54	65.13	11.74
				White	1,640	47.98	28.92	74.84	11.77
Elec	80	E6	30474	Negro	61	39.87	26.74	67.62	16.09
				White	867	48.66	28.88	78.67	14.45
Gen	40	E3	62250	Negro	113	32.55	24.98	50.00	12.06
				White	454	50.74	28.42	61.45	15.43
Gen	40	E3	64750	Negro	106	37.22	27.04	47.87	8.69
				White	402	50.62	28.52	57.17	14.04
Gen	40	E4	64750	Negro	726	41.82	27.32	42.23	13.41
				White	2,280	49.44	28.87	54.46	15.74
Gen	40	E6	64770	Negro	169	47.84	30.09	40.62	19.76
				White	547	48.27	28.35	50.61	21.74
Gen	40	E4	81150	Negro	1,045	40.61	28.09	48.41	11.03
				White	4,338	49.07	28.62	58.48	14.39
Mech	50	E3	43141E	Negro	97	36.00	25.84	56.39	7.66
				White	868	48.42	28.87	63.03	11.96
Mech	50	E4	43151E	Negro	296	39.20	26.17	53.36	10.95
				White	3,581	48.25	28.84	62.28	13.13
Mech	50	E5	43161E	Negro	135	39.39	27.37	52.07	12.97
				White	1,127	48.58	28.67	65.26	15.65
Mech	50	E6	43171E	Negro	127	41.07	29.14	55.98	18.24
				White	1,554	47.90	28.70	65.12	18.52
Mech	50	E5	60561	Negro	132	40.77	27.28	36.63	17.95
				White	417	49.25	29.10	50.42	20.18

[a]The occupational specialties tested are identified in Appendix I.

as to increase its effectiveness with respect to subgroups. The empirical finding which would most strongly suggest differential selection standards would be that of a general over- or underprediction of a subgroup, such as illustrated in examples 2, 3, and 5 in Figure 1. In analysis of variance terms, this corresponds to a "main effect" difference between subgroups on the criterion, controlling for levels of selection test scores. This is also referred to as intercept bias by Guinn *et al.* (1970b). In such a case, one subgroup is, on the whole, performing at a higher level on the criterion than would be estimated by a regression line based on the total population. Thus, the selection test is biased against that subgroup.

This overall subgroup difference, or main effect, can exist with (see examples 2 and 3 in Figure 1) or without (see example 5) a significant interaction effect, referred to by Guinn *et al.*

Table 3. **Summary of Regression Analyses**

Grade	SKT	$(R_F)^2$	$(R_R)^2$	$(df)_1$	$(df)_2$	F	Probability	Most Representative Example in Figure 1
Analysis A: F-Tests for Presence of Racial Differences (Model 1 vs. Model 3)								
E4	64550	.08198	.07984	2	2867	3.3397	.04	-
E5	64560	.04588	.04489	2	3480	1.7914	.17	1
E6	64570	.04573	.04021	2	2245	6.4907	.00	-
E5	73260	.01503	.01402	2	1403	.7141	.49	4
E4	42153	.10343	.10272	2	1751	.6932	.50	1
E6	30474	.04554	.04439	2	924	.5571	.57	1
E3	62250	.16688	.14493	2	563	7.4165	.00	-
E3	64750	.18308	.17131	2	504	3.6298	.03	-
E4	64750	.08433	.08274	2	3002	2.5944	.08	-
E6	64770	.03625	.03415	2	712	.7761	.46	1
E4	81150	.09063	.08908	2	5379	4.5739	.01	-
E3	43141E	.14877	.14395	2	961	2.7229	.07	-
E4	43151E	.09741	.09659	2	3873	1.7486	.18	1
E5	43161E	.08311	.07715	2	1258	4.0891	.02	-
E6	43171E	.09612	.09584	2	1677	.2632	.77	1
E5	60561	.02467	.01731	2	545	2.3375	.10	-
Analysis B: F-Tests for Presence of Differential Prediction (Model 1 vs. Model 2)								
E4	64550	.08198	.08180	1	2867	.5474	.45	-
E6	64570	.04573	.04222	1	2245	8.2604	.00	5[a]
E3	62250	.16688	.16662	1	563	.1711	.68	-
E3	64750	.18308	.17737	1	504	3.5227	.06	2
E4	64750	.08433	.08319	1	3002	3.7201	.05	5[a]
E4	81150	.09063	.09031	1	5379	1.8593	.17	-
E3	43141E	.14877	.14833	1	961	.5045	.48	-
E5	43161E	.08311	.07798	1	1258	7.0411	.01	2
E5	60561	.02567	.02567	1	545	.0003	.99	-
Analysis C: F-Tests for Presence of Parallel Differences (Model 2 vs. Model 3)								
E4	64550	.08180	.07984	1	2867	6.1212	.01	5
E3	62250	.16662	.14493	1	563	14.6576	.00	5
E4	81150	.09031	.08908	1	5379	7.2760	.01	5
E3	43141E	.14833	.14395	1	961	4.9448	.03	5
E5	60561	.02567	.01731	1	545	4.6762	.03	5

Note. — $(R_1)^2$ for Analysis C = $(R_F)^2$ for the same SKT in Analysis A and B.

[a]This analysis indicated an interaction; however, the model shown in example 5 in Figure 1 is a close representation.

(1970b) as slope bias. When an interaction, or slope bias, exists without a mean subgroup difference (main effect, as illustrated in example 4), there is no general inequity of selection against a subgroup. The presence of an interaction, in the absence of a general subgroup difference, does not appear as adequate justification for differential selection standards, except possibly on a purely utilitarian basis.

The identification of Negroes and whites as subgroups does not exhaust the number of possible subgroups for which the relationship between predictor and criterion can be evaluated. Indeed, subgroups can be identified in an infinte number of ways, such as whether subjects reside east or west of the Mississippi River, whether they are right- or lefthanded, or whether they have or do not have siblings. If the subgroups contained a

very large number of individuals, some subgroup differences could approach or reach statistically significant levels. From a standpoint of the effective use of manpower resources, a decision to use differential selection standards should be based on differences which are both statistically significant and practically significant. The difficulties associated with the complexity of using differential standards would preclude its adoption except in the face of rather extreme or crucial subgroup differences.

Although no selection device can feasibly provide differential treatment for all identifiable subgroups, it is important to measure and evaluate any systematic bias concerning readily identifiable subgroups for which there is sufficient reason to suspect that bias exists. Singling out Negro and white subgroups for study is motivated primarily by moral, not economic, considerations. There is substantial interest in our society in purging our institutions of any mechanisms which continue residual racial bias. It is in the context of this concern that this study was conducted.

Although the identification and comparison of individuals by race is convenient, it may be more fruitful to examine selection test validities for other types of identifiable subgroups. For example, socioeconomic, cultural, and value-system differences might appreciably affect the validity of selection tests for some subgroups which differ from the population against which the selection test was standardized. With the identification and measurement of other background factors, race might cease to make a unique contribution to group differences.

V. SUMMARY AND CONCLUSIONS

To investigate the possibility of different predictor criterion relationships for Negro and white airmen, regression analyses were conducted for both races within 16 promotion groups. The selector aptitude index from the AQE was the predictor variable and the SKT score was the criterion variable. The single basic conclusion, based on the data available in this study, is that there is no bias (*i.e.*, underprediction of criterion performance) against Negro airmen. In support of this conclusion, two specific findings of the study apply.

1. For seven promotion groups, there were no statistically significant racial differences of any kind in the predictor-criterion relationship.

2. For nine promotion groups, the Negro criterion scores were overpredicted by the selection test scores.

APPENDIX I. OCCUPATIONAL SPECIALTIES TESTED

SKT	Grade Tested	Specialty Title	Related *Dictionary of Occupational Titles* Jobs
64550	E4	Inventory Management Specialist	Receiving and Shipping Foreman
64560	E5	Inventory Management Supervisor	Manager, Machine Records Manager, Warehouse
64570	E6	Inventory Management Supervisor	Manager, Machine Records Manager, Warehouse
73260	E5	Personnel Technician	Manager, Employment Text Examiner Job Analyst
42153	E4	Aerospace Ground Equipment Repairman	Gasoline Engine Repairman Electrician, Airplane
30474	E6	Ground Radio Communications Technician	Radio Mechanic Radio Equipment Foreman
62250	E3	Cook	Cook
64750	E3	Materiel Facilities Specialist	Inventory Clerk Foreman
64750	E4	Materiel Facilities Specialist	Inventory Clerk Foreman
64770	E6	Materiel Facilities Supervisor	Manager, Warehouse
81150	E4	Security Policeman	Guard Patrolman
43141E	E3	Jet Aircraft Maintenance Specialist	Airplane Mechanic Tire Repairman
43141E	E4	Jet Aircraft Maintenance Specialist	Airplane Mechanic Tire Repairman
43161E	E5	Jet Aircraft Maintenance Technician	Airplane Inspector Tire Inspector
43171E	E6	Jet Aircraft Maintenance Technician	Airplane Inspector Tire Inspector
60561	E5	Air Transportation Supervisor	Foreman, Cargo Agent Foreman, Transportation Agent

APPENDIX II. REGRESSION EQUATIONS FOR PROMOTION GROUPS

[Model I Regression Design: SKT= B + W + (B x AQE) + (W x AQE)]

SKT	Regression Equation
64550	SKT = 0.0 (B)– .01 (W) + .42 (B x AQE) + .48 (W x AQE) + 14.52
64560	SKT = .03 (B) + 0.0 (W) + .29 (B x AQE) + .32 (W x AQE) + 30.26
64570	SKT =– 11.56 (B) + 0.0 (W) + .41 (B x AQE) + .24 (W x AQE) + 34.71
73260	SKT = 16.50 (B) + 0.0 (W) + 0.0 (B x AQE) + .25 (W x AQE) + 29.31
42153	SKT = 0.0 (B) – .26 (W) + .82 (B x AQE) + .78 (W x AQE) – 10.08
30474	SKT = – .58 (B) + 0.0 (W) + .34 (B x AQE) + .40 (W x AQE) + 17.21
62250	SKT = – .41 (B) + 0.0 (W) + .44 (B x AQE) + .65 (W x AQE) + 11.09
64750 (E3)	SKT = 37.41 (B) + 0.0 (W) + .01 (B x AQE) + .89 (W x AQE) – .41
64750 (E4)	SKT = 1.60 (B) + 0.0 (W) + .43 (B x AQE) + .51 (W x AQE) + 21.70
64770	SKT =- .66 (B) + 0.0 (W) + .31 (B x AQE) + .24 (W x AQE) + 35.98
81150	SKT = .25 (B) + 0.0 (W) + .53 (B x AQE) + .58 (W x AQE) + 14.89
43141E	SKT = .27 (B) + 0.0 (W) + .79 (B x AQE) + .91 (W x AQE) – 8.83
43151E	SKT =– .04 (B) + 0.0 (W) + .61 (B x AQE) + .67 (W x AQE) + 6.58
43161E	SKT = 25.11 (B) + 0.0 (W) + 0.0 (B x AQE) + .53 (W x AQE) + 14.27
43171E	SKT =– 1.09 (B) + 0.0 (W) + .45 (B x AQE) + .47 (W x AQE) + 16.98
60560	SKT =– 6.55 (B) + 0.0 (W) + .15 (B x AQE) + .15 (W x AQE) – 41.86